Evaluation of Spinal Tuberculosis by Using Computerized Tomography CT and Magnetic Resonance Imaging MRI scan

A Thesis Submitted for Partial Fulfillment of Academic Requirements for the Degree of Master of Diagnostic Radiology Technology

By :
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Supervisor :
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2011
Sudan University of Science and Technology

College of Graduated Studies

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تقويم درن العمود الفقري باستخدام الرنين المغناطيسي والتصوير المقطعي المحوسب

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The thesis of: Msc in Diagnostic Radiography Technology

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قال تعالى: (لَيَكَأْمِلُوا أَلْتَابَ عَنْهَا آتَفَّوا رَبْتَكَ الَّذِي خَلَقْتُمْ مِنْ نَفْسٍ وَجَدَّتِ وَخَلَقْتُهَا زَوْجَهَا وَبَتَتْ مِنْهَا رِجَالًا كَثِيرًا وَنُسِئْ وَأَنَّفَعَ الَّذِي ذَا قُسْوَةَ لَوْلَيْهُ وَالْأَرْجَامُ إِنِّي رَبُّكُمْ رَقِيبًا)

صدق الله العظيم

سورة النساء، الآية رقم (1)
Dedication

I would like to dedicate this master dissertation to spirit of my father.

To my wonderful mother, who have raised me to be the person I am today.

To my brothers and sisters whom have been with me every step of the way, through good times and bad. They have been a source of encouragement and inspiration to me throughout my life,

a very special thanks for providing a ‘writing space’ and for nurturing me through the months of writing.

Thank you for everything
ACKNOWLEDGEMENT

My acknowledgements and gratefulness at the beginning and at last is to Allah who gave us the gift of the mind.

Profound thanks and gratitude to everyone who encouraged me to complete this thesis.

My gratitude is extended to my supervisor Dr. Hussein Ahmed Hassan, all radiology department staff for their helps. Their works have stimulated and fostered my efforts in producing this research.

My thanks to my friends and colleagues in College of Medical Radiological Sciences, Elshiek Hospital, and Jabelawelia Hospital. Finally, I would like to give thank of my long-suffering family for never-ending support. May Allah almighty bless them all.
ABSTRACT:

Spinal Tuberculosis is considering the most clinically important extra pulmonary form of disease.

Early recognition is therefore necessary to minimize residual spinal deformity and/or permanent neurological deficit.

In this study, we intended to evaluate the CT and MRI images, morphology of spinal TB and correlated the imaging features of these two modalities.

A total of 30 patients, (CT: 10 patients) and (MRI: 20 patients) images were retrospectively analyzing in 30 patients with proved spinal TB.

The parameters assessed were the age distribution, signs and symptoms, pathological features and the affected spinal regions.

The most common clinical presentation was backache registered highest ratio (37.8%) among females, the Thoracic spine was the commonest site of the disease (40.0%)

Bone destruction was the most frequent CT feature of the disease (22.7%).

The paraspinal soft tissue abnormality and Compressing the spinal cord prevail (21.65%) by using MRI.

MRI offers excellent visualization of the soft tissue components of spinal tuberculosis and helps to identify disease at distant asymptomatic sites. CT is useful in assessing bone destruction, but is less accurate in defining the epidural extension of the disease and therefore its effect on neural structures.

MR imaging clearly demonstrated the extent of soft tissue disease and its effect on the spinal cord and spinal foramen in cases with doubtful CT findings.
العمود الفقري يعتبر من أهم الأشكال السريرية للإصابة خارج الرئة المعرفة المبكرة ضرورية لتقليل العاهة الناتجة عنه في العمود الفقري و أو الخلل الدائم للأعصاب.

في هذه الدراسة تم التعريف بالتصوير المقطعي المحوسوب وبالتصوير بالرنين المغناطيسي كذلك طبيعة مرض درن العمود الفقري و تم ربط مميزات التصوير في كل النوعين.

أخذنا صورا بالتصوير المقطعي لعشرة مرضى وبالتصوير بالرنين المغناطيسي لعشرين مريضا لديهم مسبقًا تشخيص بأن هؤلاء الثلاثين مريضا مصابون بدرن العمود الفقري.

من حيث العمر، الأعراض، العلامات، المميزات المرضية، ومناطق السلسلة الفقرية المتضررة.

أكثر الأعراض السريرية شيوعا كان المظهر وقد سجل أعلى نسبة (47.8%) عند الإناث.

أكثر المناطق المتضررة بالمرض شيوعا كانت منطقة الفقرات الصدرية (64%).

تحطم العظام هو الميزة الأكثر تردا في التصوير المقطعي (72.7%). في التصوير بالرنين المغناطيسي الضغط علي العمود الفقري وإصابات النسيج الناعم بجانب الفقرات كانا أكثر المميزات سرادة (21%).

يعرض التصوير بالرنين المغناطيسي رؤية ممتازة لتكوينات النسيج الناعم في السل الشوكي ويساعد لتمييز المرض في كل المواقع لكن التصوير المقطعي المحوسوب مفيد في تقييم تحطم العظام لكن أقل دقة في تعريف الامتداد الخارجي للمرض وبالتالي تأثيره على التراكيب العصبية.

التصوير بالرنين يعرض بوضوح امتداد المرض في النسيج الناعم وتأثيره على الحبل الشوكي والفتحات الشوكية في الحالات المشكوك فيها من نتائج التصوير المقطعي المحوسوب.
Abbreviations

TB: Tuberculosis
CT: Computed Tomography
MRI: Magnetic Resonance Imaging
SPECT: Single Photon Emission Computed Tomography
Ga67: Gadolinium 67
PET: Proton Emission Tomography
ESR: Erythrocyte Sedimentation Rate
CAT: Computerized Axial Tomography
PPD: Primary Pulmonary Disease
DVT: Deep Vein Thrombosis
PCV: Packed Cell Volume
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Chapter One

1.1 Introduction:

Tuberculosis (TB) is an ancient infection that has plagued humans throughout recorded history. It is still very much prevalent today. This infection remains the cause of a higher morbidity and mortality than any other infection in the world, especially in the densely populated developing countries. TB is the most common infection disease in the third world countries. It is commonly pulmonary disease but extra pulmonary disease is more common in children. About 5-10% of patients have bone and joint infection (1).

Fifty percent of patients with bone & joint TB have spinal TB called Pott’s disease. The infection reaches the spine via respiratory tract or intestine by blood stream. The infection begins from the anterior part of vertebral body, spreads to the disc and causes bone destruction and formation of abscess (2). Abscess spreads beneath the anterior longitudinal ligament and the intervertebral disc is involved with subsequent loss in disc height. As the vertebral bodies collapse into each other, a sharp angulation’s (or Kyphosis) develops. Caseation and cold abscess formation may extend into the neighboring vertebra or escape into the Para vertebral soft tissue. There is major risk of cord damage due to pressure by the abscess, displaced bone or ischemia from spinal artery thrombosis. This is called Pott’s, paraplegia (3). TB is the most common cause of non-traumatic paraplegia in the most parts of world (4).

In developing countries, TB spine remains a major health problem. This is most common and dangerous form of musculoskeletal TB (5).

Pott’s disease of the spine usually involves the mid thoracic spine. Tubercle bacilli reach the spine either haemotogenously or through lymphatic channels
from the paravertebral lymph nodes or pleural space. Pott's disease of the spine affects active period of life, it is a disease of young adult and childhood (6).

Computed tomography (CT) is a medical imaging method employing tomography created by computer processing (7). Digital geometry processing is used to generate a three-dimensional image of the inside of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation (8).

Magnetic Resonance Imaging (MRI) uses magnetic fields to create image "slices" of the human body. Like all imaging techniques, an MRI scan creates images based on differences between types of tissues. The MRI shows us the different tissues, and thus creates an image inside the body. (9)

1.2 The problem of study:
Commonly, plain x-ray of the spine may be ordered with some basic blood investigation such as hemoglobin, Erythrocyte Sedimentation Rate (ESR), and liver function tests (LFT). Based on these tests, or sometimes, in the presence of some very significant signs or symptoms, patients may be asked to undergo MRI or CT scanning. CT demonstrates bony features; while MRI demonstrates the spinal cord, its nerve roots, and the intervertebral disc between the two bones of the spine. Both these tests are complimentary in nature; doing ones does not necessarily mean that the other one is not needed.
1.3. The Objectives:

1.3.1. General Objectives:

1-To evaluate spinal TB by using CT and MRI

1.3.2. Specific Objectives:

2-To correlate the imaging features of these two modern modalities.

3-To detect the most regions of vertebrae affect and most signs and symptoms will appear.

1.4. Overview of study:

This study falls into five chapters, Chapter one, which is an introduction, deals with theoretical frame work of the study. It presents the statement of the of the study problems, objectives of the study. Chapter two, is divided into two sections, section one deals with anatomy of spinal vertebral column, pathology of spinal TB disease, Radiographic pathology, CT and MRI. Section two deals with literature review (previous studies). Chapter three deals with materials and methods; Chapter four deals with results data presentation. Chapter five discusses the data (discussion), recommendations, conclusion and references.
Chapter Two

2.1 Literature Review

2.1.1 Anatomy

The vertebral column is a remarkable structure that supports the body weight, helps to maintain posture, and protects the delicate spinal cord and nerves. It is made up of 33 vertebrae, which can be separated into cervical, thoracic, lumbar, sacral and coccygeal sections. There are some curvatures associated with the vertebral column. The cervical and lumbar sections convex forward, creating lordotic curves. The thoracic and sacral sections convex backward, creating kyphotic curves. Vertebrae vary in size and shape from section to section, but a typical vertebra consists of two main parts: the body (anterior element) and the vertebral arch (posterior element). The cylindrical body is located anteriorly and functions to support body weight. The compact bone on the superior and inferior surfaces of the body is called the vertebral end plates. The vertebral bodies are separated by shock-absorbing cartilaginous disks. These disks consist of a central mass of soft semi-gelatinous material called the nucleus pulposus and a firm outer portion termed the annulus fibrosus. Located posteriorly is the ring-like arch that attaches to the sides of the body; creating a space called the vertebral foramen. The succession of the vertebral foramina forms the vertebral canal, which contains and protects the spinal cord. The vertebral arch is formed by

- 2 pedicles, - 2 laminae, - 1 spinous process, - 2 transverse processes,
- 2 superior articular processes and 2 inferior articular processes.

The two pedicles project from the body to meet with two laminae, which continue posterior and medial to form a spinous process. The transverse
processes project laterally from the approximate junction of the pedicle and lamina. On the upper and lower surfaces of the pedicles is a concave surface termed the vertebral notch. When the superior and inferior notches of adjacent vertebrae met, they form intervertebral foramina, which allow for the transmission of spinal nerves and blood vessels. Four articular processes, two superior and two inferior, arise from the junctions of the pedicles and lamina to articulate with the adjacent vertebrae to form the apophyseal joints (facet joints). These joints give additional support and allow movement of the vertebral column.\(^{(10)}\)

There are 7 cervical vertebrae. The vertebrae vary in size and shape to a large degree. Within the transverse process of each cervical vertebra is a transverse foramen. The foramina allow passage of the vertebral arteries as they ascend to the head.\(^{(10)}\)

Twelve vertebrae make up the thoracic section. They have typical vertebral configurations except for their characteristics costal facets, which articulate with the ribs. The head of the rib articulates with the vertebral bodies, while the tubercle of the ribs articulates with the transverse processes. The articulations between the ribs the vertebral bodies are costovertebral joints, and the articulations between the ribs and the transverse process are costotransverse joints. The spinous processes of the thoracic vertebrae are typical long and slender, projecting inferiorly over the vertebral arches of the vertebrae below.

The lumbar section typically consists of five vertebrae. Their massive bodies increase in size from superior to inferior. The largest of the lumbar vertebrae is L5, it is characterized by its massive transverse processes. The entire weight of the upper body is transferred from the 5th lumbar vertebra to the base of the sacrum across the L5-S1 disk.\(^{(10)}\)
The sacral section consists of 5 vertebrae that fuse to form the sacrum. Their transverse processes combine to form the lateral mass (ala), which articulates with the pelvic bones at the sacroiliac joints. Located within the lateral masses are the sacral foramina, which allow for the passage of nerves. The first sacral segment has a prominent ridge located on the anterior surface of the body termed the sacral promontory. The bony landmark is used to separate the abdominal cavity from the pelvic cavity. The spinous process of the 5th sacral segment is absent; leaving an opening termed the sacral hiatus. Located inferior to the 5th sacral segment is the coccyx, which consists of 3 to 5 small fused bony segments. Posterior projections from the first coccygeal segment are called cornu. The coccyx represents the most inferior portion of the vertebral column and is commonly called the tailbone. (10)
Ligaments of the Spine: Several ligaments enclose the vertebral column to help protect the spinal cord and maintain the stability of the vertebral column. Two of the larger ligaments are the anterior and posterior longitudinal ligaments. The anterior longitudinal ligament is a broad fibrous band that extends downward from C1 along the entire anterior surface of the vertebral bodies to the sacrum. This ligament connects the anterior aspects of the vertebral bodies and inter-vertebral disks to maintain stability of the joints and to help prevent hyper-extension of the vertebral column. It is thicker in the thoracic region than in the cervical and lumbar regions. The posterior longitudinal ligament is narrower and slightly weaker than the anterior longitudinal ligament. It lies inside the vertebral canal and runs along the posterior aspect of the vertebral bodies. The posterior longitudinal ligament runs the entire length of the vertebral column beginning at C2. This ligament helps to prevent posterior protrusion of the nucleus pulposus and hyper-flexion of the vertebral column. The ligamentum flavum are strong yellow ligaments (consisting of yellow elastic tissue) present on either side of the spinous process. They join the laminae of adjacent vertebral arches, helping to preserve the normal curvature of the spine. The suraspinous ligament is a narrow ligament that joins the tips of the spinous processes from the 7th cervical vertebra to the sacrum. The supraspinous ligament continues superiorly as the ligamentum nuchae of the cervical spine. Other ligaments of the spine serve to connect the cervical vertebrae and cranium to provide mobility and protection for the head and neck. The alar ligaments are two fibrous cords that extends from the sides of the odontoid process to the later margins of the foramen magnum. They limit rotation and flexion of the head. The transverse ligament extends across the ring of the C1 to form a
sling over the posterior surface of the odontoid process. The transverse ligament functions to hold the odontoid process of C2 against the anterior arch of C1. The transverse ligament is sometimes called the cruciform ligament because of its cross-like appearance.\(^{10}\)

![Diagram of spinal ligaments](image)

**Figure 2.2 Shows ligaments of spine**

- **Spinal Cords: Meninges:** The spinal cord functions as a large nerve cable that connects the brain with the body. It begins as a continuation of the medulla at the inferior margin of the brain stem and extends to approximately the first or the second lumbar vertebra. Through its length, the delicate spinal cord is surrounded and protected by cerebrospinal fluid, which is contained in a sac formed by the spinal meninges. Spinal meninges are continuous with the cranial meninges and adhere to the bony vertebral column. Notable amounts of epidural fat can be identified surrounding the spinal meninges.\(^{10}\)
• **The major psoas muscle:** The psoas major is a long fusiform muscle located on the side of the lumbar region of the vertebral column and brim of the lesser pelvis. It joins the iliacus muscle *to* form the iliopsoas. In less than 50 percent of human subject. \(^{(11)}\)

![Figure 2.3 The major psoas muscle](image)
2.1.2 Pathology of Spinal TB disease

• Synonyms: Pott's syndrome, Pott's caries, Pott's curvature, angular kyphosis, kyphosis secondary to tuberculosis, TB of the spine, tuberculous spondylitis and David's disease.\textsuperscript{(12)}

• General information: Pott's disease is named after Percival Pott (1714-1788), who was a surgeon in London. Pott's disease is TB of the spinal column (must not be confused with Pott's fracture of the ankle).\textsuperscript{(12)} This is usually a disease of childhood in developing countries. The Thoracic, lumbar and cervical vertebrae are affected in that order of frequency. Often more than one vertebra is involved; they are usually adjacent but occasionally widely separated. The lesion commonly arises near the intervertebral disk, which soon becomes involved. When the infection begins in or spreads to the periosteum, the caseous material is invaded by polymorphonuclear leukocytes and converted into pus. This often extends to form a paravertebral abscess at the front and sides of the vertebrae which may spread, especially under the anterior vertebral ligament, to infect other vertebrae. Later the pus sometimes penetrates the sheaths of muscles and tracks along their length. In this way TB of the lumbar vertebrae may cause a \textit{psoas} or \textit{lumber 'cold' abscess}, the pus tracking beneath the psoas sheath to point in the inner aspect of the thigh. When the cervical vertebrae are affected, a large collection of pus may form behind the pharynx - \textit{retropharyngeal abscess}. The cold abscess may burst through the skin with the formation of a sinus which tended to become secondarily infected. Such patients are especially liable to develop \textit{amyloid disease}. Bone destruction may result in vertebral collapse.
anteriorly, and especially when two adjacent vertebrae are involving, angulation of the spinal column (kyphosis) results.\(^{(13)}\)

About a quarter of patients with vertebral TB develop paraplegia, usually as a result of compression of the cord by extradural abscess, granulation tissue, sequestrated bone or disc material. In less than 20% of these patients the infection penetrates the dura to produce an intradural abscess or to involve the cord directly. Occasionally, the tubercle bacilli spread to the spinal subarachnoid space and TB meningitis results. In immigrants TB paraplegia may occur without vertebral disease probably by extension from blood borne focus of infection in the meninges. Paraplegia arising years after the original infection may result from reactivation of the infection or from stretching of the cord over the apex of the severe kyphosis; in the latter case the prognosis is less good.\(^{(13)}\) Spondylodiskitis refers to a combined infection of the disc space and one or both adjacent vertebrae. It is the most common form of inflammatory spinal disease encountered in adult. Two main types are distinguished based all etiology and causative agent: -\textit{Sponeous} or post interventional spondylodiscitis -Tuberculous (specific) and non-tuberculous spondylodiscitis

10% of TB patients suffer bone and joint involvement. 50% of these patients develop TB spondylodiscitis, and half of these have history of pulmonary TB with hematogenous spread of infection to a disc space and the adjacent vertebrae bodies. The resulting destruction most commonly involves the anterior two-third of the vertebral body and spares the posterior elements. There is a progressive loss of disc high over time, although the discspace usually remains intact for longer period than in acute infections with \textit{staphylococcus aureus}. A conspicuous paraspinal
soft-tissue mass frequently develops and is often associated with an abscess, usually sterile, that may show anterior or occasional posterior subligamentous extension over several segments. (14)

2:1:3 Radiographic pathology

Vertebral osteomyelitis is usually caused by hematogenous spread to the vertebral body, whereas infection of the intervertebral disc (infection discitis) is due to osteomyelitis of the adjacent vertebral body that secondarily invades the disc or to direct contamination of the disc itself during surgical spine procedures or interventional spine procedures such as discography. Some people prefer the term spondylodiscitis because it conveys the intertwined relationship between infection of the vertebrae and intervening disc. The most common pyogenic organism to infect the spine is staphylococcus aureus. Immunocompromised people are susceptible to fungal infections and to bacterial and TB diseases. (15)

Radiographically, the hallmarks of biogenic infection are loss of disc space height and destruction of the vertebral endplates, both of which occur early in the course of disease, usually in the first few weeks of the infection. In contrast TB of the spine (Pott disease) shows marked osteopenia and bone destruction but with relative sparing of the disc space and endplates until late in the course of the disease, typically over several months. A characteristic late sequela of the vertebral and disc destruction of TB involvement of the thoracic spine is the sharply angled kyphotic "gibbus" deformity. (15)

MRI is more sensitive than radiography and CT for the early detection of vertebral infection by displaying a marrow edema pattern in the adjacent vertebra and endplates. Typically, there is also high signal intensity within the
disc on T2-weighted imaging and loss of intranuclear cleft. In addition, Pyogenic and TB spondylitis can have associated paravertebral and epidural abscesses, but, as previously mentioned, TB abscesses look "cold". The TB infection also can spread into the adjacent psoase muscles, causing large cold abscesses that may track up and down the affected muscles. These abscesses may calcify, unlike pyogenic abscesses, and the calcification is best appreciated on radiographics or CT. (15)

TB is spondylitis also may demonstrate a subligamentous component involving the interior longitudinal ligament or the posterior longitudinal ligament, through which the infection can spread to adjacent vertebral levels; the presence of multiple levels of vertebral involvement suggests TB rather than pyogenic infection, but fungal infection and sarcoidosis of the spine also can have this multiple appearance. Gadolinium contrast should be administered as part of MR examination to help distinguish abscess from non-drainable phlegmon. Fungal infections have a predilection for the posterior elements of the spine and may show preservation of normal disc signal intensity and the intranuclear cleft on T2-weighted imaging even with disc involvement. A pitfall in the interpretation of disc space infection on MRI is severe degenerative disc disease with disc narrowing, endplate irregularity, and adjacent granulation-type endplate changes. (15)

The edema-like pattern in the endplates on either side of the disc can look similar to infection, and the involved regions can show enhancement of the vertebral bodies, endplates, and even portions of the disc with intravenous gadolinium administration. However, if the patient has been complaining of pain for several weeks to months and the MR examination shows no evidence
of endplate destruction or paravertebral or epidural abscess, the process is more likely non-infected degeneration rather than a pyogenic process. (15)

Moreover, the non-infected patient is a febrile and will not have an elevated white blood cell count, erythrocyte sedimentation rate, or C-reactive protein level. CT can be useful of elevating endplate irregularities in equivocal cases of infection versus degeneration to determine whether the irregularities are non-corticated infection erosion or corticated degenerative Schmoral nodes. CT also can be helpful for elevating the degree of frank bone destruction and for guiding percutaneous biopsy. Early investigation with PET scanning suggest that it is more accurate than MRI for distinguishing true infection spondylodiscitis from severe granulation – type degenerative disc disease, but it may not be practical because of its cost. Instead, Ga67, especially when using single photon emission CT (SPECT) may be a reasonable alternative because it as sensitive and slightly more specific than MRI for viewing spinal infection and surrounding soft tissue involvement. A mimicker of disc space infection on radiographs is dialysis spondylo-arthropathy. People on long term of hemodialysis may have accumulation of amyloid in the disc space with resultant narrowing or loss of disc space and endplate erosion or destruction. The history of hemodialysis and lack of pain with normal C-reactive protein should help to distinguish the two. However, dialysis patients do have a higher than normal risk for developing osteomyelitis. (15)
2:1:4 CT:

CT is a medical imaging technique, which employs tomography, where digital geometry processing is used to generate a three dimensional image of an object from a large series of two dimensional image taken around a single axis of rotation. In computed tomography, the image is made by viewing the patient via x-ray imaging from numerous angle, by mathematically reconstructing the detailed structures and displaying the reconstructed image on a video monitor.\(^{(16)}\)

A computerized axial tomography scan is more commonly known by its abbreviated name, CAT scan or CT scan. It is an x-ray procedure which combines many x-ray images with the aid of a computer to generate cross-sectional views and, if needed, three-dimensional images of the internal organs and structures of the body. A CAT scan is used to define normal and abnormal structures in the body and/or assist in procedures by helping accurately guide the placement of instruments or treatments. A large donut-shaped x-ray machine takes x-ray images at many different angles around the body. These images are processed by a computer to produce cross-sectional pictures of the body. In each of these pictures the body is seen as an x-ray "slice" of the body, which is recorded on a film. This recorded image is called a tomogram. "Computerized Axial Tomography" refers to the recorded tomogram "sections" at different levels of the body.\(^{(17)}\)

Imagine the body as a loaf of bread and you are looking at one end of the loaf. As you remove each slice of bread, you can see the entire surface of that slice from the crust to the center. The body is seen on CAT scan slices in a similar manner from the skin to the central part of the body being examined.
When these levels are further "added" together, a three-dimensional picture of an organ or abnormal body structure can be obtained. CAT scans are performed to analyze the internal structures of various parts of the body. This includes the head, where traumatic injuries, (such as blood clots or skull fractures), tumors, and infections can be identified. In the spine, the bony structure of the vertebrae can be accurately defined, as can the anatomy of the intervertebral discs and spinal cord. In fact, CAT scan methods can be used accurately to measure the density of bone in evaluating osteoporosis.

Occasionally, contrast material (an x-ray dye) is placed into the spinal fluid to further enhance the scan and the various structural relationships of the spine, the spinal cord, and its nerves. CAT scans are also used in the chest to identify tumors, cysts, or infections that may be suspected on a chest x-ray. CAT scans of the abdomen are extremely helpful in defining body organ anatomy, including visualizing the liver, gallbladder, pancreas, spleen, aorta, kidneys, uterus, and ovaries. CAT scans in this area are used to verify the presence or absence of tumors, infection, abnormal anatomy, or changes of the body from trauma. The technique is painless and can provide extremely accurate images of body structures in addition to guiding the radiologist in performing certain procedures, such as biopsies of suspected cancers, aspiration of internal body fluids for various tests, and the draining of abscesses which are deep in the body. Many of these procedures are minimally invasive and have markedly decreased the need to perform surgery to accomplish the same goal.
Figure 2.4 Computed Tomography (CT) Machine

2:1:5 MRI:

An MRI (or magnetic resonance imaging) scan is a radiology technique that uses magnetism, radio waves, and a computer to produce images of body structures. The MRI scanner is a tube surrounded by a giant circular magnet. The patient is positioned on a moveable table couch that is travelled into the magnet during scan. The magnet produced a strong magnetic field that aligns the protons of hydrogen atoms of the patient, which are then exposed to a beam of radio waves. This spins the various protons of the patient's body, and they produce a faint signal that is detected by the receiver portion of the MRI scanner. The receiver information is processed by a computer, and an image is produced.

The image and resolution produced by MRI is fine details and can detect tiny changes of structures within the body. In some cases, contrast agents, such as gadolinium, are used to increase the accuracy of the images. An MRI scan can
be used as an extremely accurate method of disease detection throughout the body. In the head, trauma to the brain can be seen as bleeding or swelling. Other abnormalities often found include brain aneurysms, stroke, tumors of the brain, as well as tumors or inflammation of the spine.

Neurosurgeons use an MRI scan not only in defining brain anatomy but in evaluating the integrity of the spinal cord after trauma. It is also used when considering problems associated with the vertebrae or intervertebral discs of the spine. An MRI scan can evaluate the structure of the heart and aorta, where it can detect aneurysms or tears. It provides valuable information's on glands and organs within the abdomen, and accurate information about the structure of the joints, soft tissues, and bones of the body. Often, surgery can be deferred or more accurately directed after knowing the results of an MRI scan.

An MRI is a completely different technology from an x-ray and CT scan and represents the single most useful imaging study available for spine surgery.

It is particularly useful as an aid in the assessment of certain conditions by providing detail of the disc (such as for degenerative disc disease, isthmic spondylolisthesis) and nerve roots (such as for lumbar disc herniation, lumbar spinal stenosis). MRI scans are also useful to rule out tumors or spinal infections.

Physicians usually have a good idea of what they are looking for on the MRI scan before one is performed. The MRI scans are most commonly used for presurgical planning, making a map such as for a decompression or a lumbar spinal fusion. MRI scans are extremely sensitive in pick up information about disease normality of the discs, as well as the presence of any any abnormality e.g tumors or a lumbar disc herniation pinching the nerve roots. (18)
Figure 2.6 Magnetic Resonance (MRI) Machine
2.2 REVIOUS STUDY

Dr. EL Bashir Gusm Elbari Ahmed, MBBS (1997): Stated in their study of Computed Tomographic evaluation of Pott's disease: Fifty patients admitted to Khartoum Teaching Hospital and Shaab Teaching Hospital in the period from October 1994 - October 1996 and diagnosed as Pott's disease of the spine were included in the study. Patients below the age of 15 years were excluded. Full history and physical examination were performed in each patient. Hemoglobin concentration, packed cell volume (PCV) Erythrocyte Sedimentation Rate (ESR), White Blood Cell Count total and differential was done for all patients together with chest X-Ray, spinal X-Ray A.P. and lateral views. Myelogram, CT scan, Mantoux and CSF examinations were done when needed. The mean age of the study group was 41.3±1 7.6 years, with male to female ratio of 30:20 (3:2). TB spondylitis affect the cervical spines in 2 cases (3.45%), the upper thoracic in 10 cases (17.24%), mid thoracic 20 times (34.48%), lower thoracic 20 cases (34.48%), lumber spines 6 cases (10.35%) and no lesion in the sacral spines. Pulmonary TB was found in 18 patients (36%) together with Pott's disease of the spine. All patients came with back pain, lower limbs weakness and the course of the disease was progressive, 35 patients (70%) were unable to walk, and the sphincters were affected in 37 patients (74%) of the cases. On medical treatment 37 patients (74%) showed progressive improvement, 5 patients (10%) remained static or deteriorated and 18 patients (16%) died. 2 of those who died had developed severe bed sores and anemia before death, 3 of them developed deep vein thrombosis (DVT) and died. Even though they started anticoagulant therapy, 2 patients developed drug induced hepatitis and died in spite of stopping the drugs, and one patient had got miler TB on top of Pott's disease. Presence of pulmonary TB showed no adverse effect on outcome, of treatment. Surgery done on 2 patients showed good outcome.¹⁹
Obajimi et al (2004): Stated in their study of Computed tomographic evaluation of Pott's disease in Accra that radiological investigations are central in the diagnosis and management of TB spine. In Ghana there is a dearth of literature on the disorder. This paper seeks to describe the CT features of the bony and soft tissue changes in Pott's disease. It is a descriptive report of the CT scans performed on 30 patients with proven Pott’s disease from January 1998 to December 2000 at the Korle Bu Teaching Hospital Accra, Ghana. The disorder was common among children and young adults (76.7%). Chronic back pain was the frequent presenting complains (53.3%). The dorsal spine remains the site of preference while T11 recorded the highest incidence (73.3%). The vertebral body was destroyed in all the cases and the fragmentary type of bone destruction was the common observation. The incidence of cord compression demonstrated by CT was high (73.3%). Other findings were paraspinal and epidural masses observed in (66.7%) and (73.3%) respectively. CT images demonstrated the spinal level of destruction. Improved resolution also showed detailed changes within the outlined soft tissue masses, facilitating early diagnosis and prompt initiation of therapy. (20)

Bell et al (1990): Stated in their study of MRI diagnosis of Tuberculous vertebral osteomyelitis that two patients with suspected tuberculous spondylitis and one patient with previous Pott’s disease were evaluated preoperatively with magnetic resonance imaging (MRI). The MRI provided more exact anatomic localization of vertebral and paravertebral tuberculous abscesses in multiple planes not previously available with more conventional diagnostic methods in the patients with suspected tuberculous spondylitis. This was helpful for localization in planning of surgical approaches. In the patient with previous
Pott's disease, spinal cord compression was detected using MRI, which showed no evidence of active tuberculosis. Two case reports are offered to show the benefit of using MRI as a diagnostic tool in preoperative evaluation and as a method of monitoring treatment response of tuberculous spondylitis. The third case shows the benefit of using MRI to rule out active infection and to detect other forms of spinal pathology. (21)

Wellons et al (2002): Stated in their sacral tuberculosis a case report and review of the literature. They present a patient with a heterogeneously enhancing lesion within the body of the sacrum and the sacral canal. Sacral TB was suspected because of a history of familial exposure. Few cases isolated to the sacrum have been reported in the literature. The characteristic histopathologic and magnetic resonance imaging (MRI) findings are also presented. A 31-year-old African-American male presented with an 8-month history of lower back pain radiating into his legs as well as numbness and weakness of the right foot. His history revealed PPD conversion following an exposure to active pulmonary TB 3 years prior for which he received 6 months of isoniazid prophylaxis. An MRI scan revealed a large heterogeneously enhancing lesion involving the sacrum with extension into the sacral canal. The patient underwent computed tomography (CT)-guided needle biopsy of the sacral lesion. Cytopathologic examination revealed caseating granulomas. Acid-fast bacilli cultures were positive for Mycobacterium tuberculosis. He was placed on a 6-month course of isoniazid, rifampin, pyrazinamide, and ethambutol. At 3-month follow-up, his examination and symptoms had improved. Sacral TB is an extremely rare cause of lower back pain which a radiate into the lower extremities. (22)
Chapter Three

Materials and Methods

3.1 Materials

3.1.1 The patients:
Sample of (30) patients who were clinically diagnosed as Spinal TB (Pott's disease) and had different signs and symptoms. Their range ages between 5 – 85 yrs. 15 patients are females and 15 Patients are males.

3.1.2 Study Area:
Shaab Teaching Hospital, Abuanja TB Hospital, Gadaref Hospital – Jabelawlya Hospital, Some of CT centers in Sudan e.g Elnilain Medical Diagnostic Center, Buqaa Center, Gadaref Daignsotic Center.
Some of MRI centers in Sudan e.g. Modern Medical Center, Khartoum Advanced Diagnostic Center, Yastbshroon |Medical Center, Alamal Diagnostic Center,

3.1.3 Study Duration:
The study was conducted in period of March 2011 - October 2011.

3.1.4 CT Machine:
GE Medic 16 Slice.

• CT Technique for Spine:
- Patient preparation:
All metallic object should be removed from the area to be studied.
The Pt should be instructed to empty the bladder sonly before the scan is started, because the IV contrast medium reached the bladder rabidly.
The patient not need to be fasting for the scan.
- Positioning and scanning protocols:
Axial slices 3mm thickness are preferred in the cervical spine and the lumbar area. The axial slices should also be done parallel to disc space.

A good overall assessment of the spine could be with 5mm thickness slices obtained every 4mm

3.1.5 MRI Machine:
Philips 1.5 Tesla

- **MRI Technique for spine:**
  - Pt position:  -Pt lies supine  -The neck coil placed under or around the cervical region, that it should extend from the base of the skull to the sternoclavicular joints.
  - The longitudinal alignment light lies in the medline, and the horizontal alignment light passes through the level of the hyoid bone. – Breathing gating leads are attached if required.
- Suggested protocol:  - Sagittal / coronal and axial SE/FSE T1 coherent GRE T2*: act as localizer, medium slice.
- Sagittal SE/FSE T2 or coherent GRE T2*: thin slices /gap are prescribed on either side of the longitudinal alignment light.
- Sagittal SE/FSE T1: thin slices /gap are prescribed on either side of the longitudinal alignment light.
- Axial/ oblique SE/FSE T1/ T2 or coherent GRE T2*: thin slices/gap are angled so that they are parallel to the disc space or perpendicular to the lesion under examination one block.
Pt position: Pt lies supine on the examination couch with the spinal coil extending from the top of the shoulder to the lower costal margin. The longitudinal alignment light lies in the midline and the horizontal alignment light passes through the center of the coil - breathing gating leads are attached if required.

-Suggested protocol: Sagittal / coronal and axial SE/FSE T1 coherent GRE T2*: act as localizer, medium slice.
Sagittal SE/FSE T2 or coherent GRE T2*: thin slices /gap are prescribed on either side of the longitudinal alignment light.
Sagittal SE/FSE T1: thin slices /gap are prescribed on either side of the longitudinal alignment light.
Axial/oblique SE/FSE T1/ T2 or coherent GRE T2*: thin slices/gap are angled so that they are parallel to the disc space or perpendicular to the lesion under examination one block.

Lumbar spine: Equipment: Posterior spinal coil /phased array spinal coil - Foam pads to elevate the knee - Ear plugs
-Pt position: Pt lies supine on the examination couch with their knees elevated over a foam pad, for comfort and to flatten the lumbar curve so that the spine lies near to the coil. The coil should extend from the xiphsternum to the to bottom of the sacrum.
The longitudinal alignment light lies in the midline and the horizontal alignment light passes just below the lower costal margin.
- Suggested protocol: Sagittal / coronal and axial SE/FSE T1 coherent GRE T2*: act as localizer, medium slice.
  - Sagittal SE/FSE T2 or coherent GRE T2*: thin slices /gap are prescribed on either side of the longitudinal alignment light
  - Sagittal SE/FSE T1: thin slices /gap are prescribed on either side of the longitudinal alignment light
  - Axial/ oblique SE/FSE T1/ T2 or coherent GRE T2*: thin slices/gap are angled so that they are parallel to each disc space and extend from lamina below to the lamina above the disc.

3.2. Methods:

3.2.1 Method of Data Collection:
For each patient the diagnosis is correlative using either CT scan or MRI scan. Then it followed by evaluation to find out if the patient had Spinal TB disease or not. The signs and symptoms of the patients were also evaluated.

3.2.2. Method of data analysis:
The data was analyzed by using statistical package, Statistical Package for Social Studies (SPSS) under windows.

3.2.3. Data Storage Method:
- Data in correspondence with the thesis procedures will be stored safely in personal computer and pass-worded computer.
- Patient questionnaire will be kept safely and securely.

3.2.4. Ethical Issues:
- Permission of Radiology department and patients arise at the area of the study must be taken to use the patients’ data.
- No patients’ informations were published.
Chapter Four

The Results

This study was conducted to evaluate spinal Tuberculosis by using CT (10 patients) and MRI (20 patients). Images were retrospectively analyzed in 30 patients (male 15) and (female 15) at age range about from 5 years to 70 years which had different signs and symptoms with proved and diagnosed spinal TB by CT or MRI.

*Table 4-1. Shows age distribute on among sample*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-15</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>13.6 %</td>
</tr>
<tr>
<td>16-26</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>16.6 %</td>
</tr>
<tr>
<td>27-37</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>16.6 %</td>
</tr>
<tr>
<td>38-48</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>16.6 %</td>
</tr>
<tr>
<td>49-59</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>16.6 %</td>
</tr>
<tr>
<td>60-70</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>20 %</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>100 %</td>
</tr>
</tbody>
</table>
Figure 4-1. The age group distribute on of the sample

Table (4-1) and Fig. (4-1) show that females (50%) and males (50%) are equal distributed among sample of study.
Table 4-2. Shows signs and symptoms among the sample

<table>
<thead>
<tr>
<th>Symptoms and Signs</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck Pain</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>8.1 %</td>
</tr>
<tr>
<td>Inability or difficulty of Walking</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>14.1 %</td>
</tr>
<tr>
<td>Weight Loss</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1.6 %</td>
</tr>
<tr>
<td>Back pain</td>
<td>7</td>
<td>11</td>
<td>18</td>
<td>30 %</td>
</tr>
<tr>
<td>Fever &amp; Cough</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>8.1 %</td>
</tr>
<tr>
<td>Upper &amp; lower limbs weakness</td>
<td>8</td>
<td>6</td>
<td>14</td>
<td>22.2 %</td>
</tr>
<tr>
<td>Numbness</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>10 %</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>6.0 %</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>29</td>
<td>62</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Figure 4-2: Shows the signs and symptoms distribution among the sample.
Table (4-2) and Fig. (4-2) show that the back pain registered highest ratio (37.8%) among females, (20.7%) upper and lower limbs weakness, (13. %) inability or difficulty of walking, (6.9%) neck pain. While in males (24.2%) for upper and lower limbs weakness as highest ratio, flowed by numbness and difficulty or inability of walking. (15.2%) here male couldn't suffer from Weight loss but from neck pain, fever and cough at the same level 9.1%.
### Table 4-3. Pathological Features of Spinal TB disease patients

<table>
<thead>
<tr>
<th>Pathological Features</th>
<th>Findings</th>
<th>Total</th>
<th>percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CT</td>
<td>MRI</td>
<td></td>
</tr>
<tr>
<td>Sclerosis</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Narrowing of the disc</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Gibbus deformity</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Paraspinal soft tissue abnormality</td>
<td>3</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Psoas muscles abnormality</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Compressing the spinal cord</td>
<td>1</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Bone destruction or fracture</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Spondylodiscitis</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
<td><strong>37</strong></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>

Table (4-3) and fig. (4-3) show that the paraspinal soft tissue abnormality and Compressing the spinal cord prevail (21.65%) by using MRI for pathological features of spinal TB flowed by 10.8% and 8.1% for paraplegia and narrowing of the disc space respectively while 5.4% recorded for Gibbus deformity, psoas muscles abnormality, Spondylodiscitis and bone destruction or fracture, but in CT they recorded 4.5%, 13.6%, 9% and 22.7% respectively. Sclerosis, narrowing of the disc Paraspinal soft tissue abnormality in the same level (13.6%), 4.5% for Compressing the spinal cord and paraplegia. 2.7% is for sclerosis as lower percentage recorded in MRI there were other features seen in MRI 13.5% but never seen in CT. While narrowing of the disc prevails (10.85%) among the same.
<table>
<thead>
<tr>
<th>Regions of vertebrae</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical region</td>
<td>4</td>
<td>13.3 %</td>
</tr>
<tr>
<td>Thoracic</td>
<td>12</td>
<td>40 %</td>
</tr>
<tr>
<td>Lumbar</td>
<td>10</td>
<td>33.4 %</td>
</tr>
<tr>
<td>Sacral Region</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>Multiple regions</td>
<td>4</td>
<td>13.3 %</td>
</tr>
</tbody>
</table>

*Table 4-4. Shows regions of vertebrae affected by Spinal TB.*

![Bar chart showing frequency and percentage of regions affected by Spinal TB](chart.png)

*Figure 4-4. Shows regions of vertebrae affected by Spinal TB.*

Table (4-4) and fig. (4-4) show that thoracic is the most region of vertebrae affected by Spinal TB registered (40%), followed by lumbar (33.4%), cervical region (13.3%) and multiple regions (13.3%). While sacral region was not affected by Spinal TB.
Chapter Five
Discussion, Conclusion and Recommendations

5.1. Discussion:
The sample of study were 30 patients, 15 females and 15 males both of them had spinal TB disease in lumbar, thoracic and cervical spines. The paraspinal soft tissue abnormality prevails (21.65%) by using MRI for pathological features of spinal TB flowed by 10.8% and 8.1% for paraplegia and narrowing of the disc space respectively while 5.4% recorded for Gibbus deformity, psoas muscles abnormality, spondylodiscitis and bone destruction or fractures, but in CT they recorded (4.5%), (13.6%), (9%) and (22.7%) respectively. Sclerosis, narrowing of the disc paraspinal soft tissue abnormality in the same level (13.6%), 4.5% for compressing the spinal cord and paraplegia 2.7% is for sclerosis as lower percentage recorded in MRI There were other features seen in MRI 13.5% but never seen in CT.

While narrowing of the disc prevails (10.85%) among the same Thoracic spine is the most affected of vertebrae with TB with (40%), followed by lumbar (33.4%), and cervical region (13.3%). (13.3%) had TB in multiple regions While sacral region was not affected by spinal TB.

TB is the most common infection disease in the third world countries. It is commonly pulmonary but extra pulmonary disease is more common in children. In developing countries, TB spine remains a major health problem. This is most common and dangerous form of musculoskeletal TB of multilevel infection.
5.2. Conclusion

Like all imaging techniques, an MRI scan produce images based on differences between types of tissues contrast. The MRI shows us the different tissues, and thus produces an image inside the body. MRI and CT are used to evaluate affection of Spinal TB among (30) patients their range ages between 5 to 85 years' females and males, who were clinically diagnosed as Spinal TB and have different signs and symptoms. Regarding signs of such disease, the back pain registered highest ratio (37.8%) among females, while in males, (24.2%) numbness as highest ratio. For pathological features of spinal TB patients, the paraspinal soft tissue abnormality prevails (21.65%) by using MRI. While narrowing of the disc prevails (10.85%). Thoracic is the most region of vertebrae affected by spinal TB registered (40%), while sacral region was not affected by spinal TB.
5.3. Recommendations

- The theories of hematogenous and lymphatic spread to vertebral foci are discussed.
- The various pathological types of involvement and their consequences are described.
- The treatment of complications is detailed.
- The care of paraplegics is described and the necessity emphasized for radical operative measures when indicated.
- Multicentric spinal TB with a concomitant bacterial infection of the cervical lesion tends to occur in high risk patients (e.g., HIV-positive persons, immigrants, and homeless persons) who present with back or neck pain. In such patients, a high index of suspicion helps the clinician detect the spinal lesions in their early stages. Prompt diagnostic evaluation and proper treatment prevent the predictable catastrophic outcome (i.e., permanent neurologic deficit, death).
- When spinal TB is detected, involvement of other sites should be investigated. If concomitant infection is present, it should be treated with appropriate parenteral antibiotics.
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DEFORMITY ABSCESS